

# The Potential Consequences of Climate Variability and Change

## FORESTS

### A Sticky Situation



#### AN ACTIVITY RESOURCE FOR TEACHERS

#### *Responding to National Education Standards in:*

- *English Language Arts*
- *Geography*
- *Mathematics*
- *Science*
- *Social Studies*

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**T**his learning activity was developed to examine the potential impacts of climate variability and change. Each activity is part of an overall series entitled *The Potential Consequences of Climate Variability and Change*, which includes 1–12 teacher resources. Twelve modules (10 printed and 2 online resources) comprise the set and are presented below:

### **OVERVIEW**

- Too Many Blankets (Grades 1–4)
- Global Balance (Grades 5–12)

### **AGRICULTURE**

- El Niño (Grades 5–8)  
This activity is provided in an online format only and is available at <http://ois.unomaha.edu/casde/casde/lessons/Nino/teacherp.htm>.
- The Great American Desert? (Grades 9–12)  
This activity is provided in an online format only and is available at <http://ois.unomaha.edu/casde/casde/lessons/grass/teacherp.htm>.

### **COASTAL AREAS**

- What Could a Hurricane Do to My Home? (Grades 5–8)
- What Is El Niño? (Grades 5–8, 9–12)
- Coral Reefs in Hot Water (Grades 9–12)

### **FORESTS**

- A Sticky Situation (Grades 5–8)
- Planet Watch (Grades 9–12)

### **HUMAN HEALTH**

- Beyond the Bite: Mosquitoes and Malaria (Grades 5–8, 9–12)
- Climate and Disease: A Critical Connection (Grades 9–12)

### **WATER**

- Here, There, Everywhere (Grades 7–8, 9–12)

The development of the activities was sponsored by the National Aeronautics and Space Administration and the Environmental Protection Agency, in support of the US Global Change Research Program. The Institute for Global Environmental Strategies implemented the effort. For more information, see <http://www.strategies.org>. For additional resources, please visit <http://teach.earth.com>—Resources for Teaching and Learning about Earth System Science..

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# Climate Variability & Change

## FORESTS

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## ACTIVITY

# A Sticky Situation



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# A Sticky Situation



**T**his activity explores the potential impact of climate variability and change on one of Earth's increasingly most vulnerable resources, our forests. Although the activity is designed to tap specific skills and knowledge through scientific inquiry, its broader intent is to stimulate thought about the long-term impacts of a warmer planet.

## **GRADE LEVELS**

Grades 5–8

## **TIME REQUIRED**

Three to four 45-minute class periods

## **OBJECTIVES**

The present activity focuses on the impact of climate change on a sugar maple farm in New England. The scenario invites students to examine higher level issues of climate variability and change by creating a practical, scientifically sound model to address specific points of a localized socioeconomic situation.

Students will:

- Examine the issues as they relate to a specific, socially relevant situation;
- Investigate claims that support opposing viewpoints;
- Determine whether the issues constitute a realistic problem;
- Analyze scientific evidence about the situation; and
- Present and defend their recommendations for action.

The activity mirrors the scientific process, and the pedagogical principles used in its design are constructivist in viewpoint.

Students will:

- Voice their prior understanding of the issues;
- Confront their level of understanding by considering opposing viewpoints;

- Engage in cooperative dialogue with other students to redefine their own position; and
- Present a revised, personal view of the situation, informed by scientific scrutiny.

## **KEY QUESTIONS STUDENTS SHOULD ADDRESS**

1. Can we safely say that the rate of climate variability and change is increasing?
2. What does the evidence say about these changes? Do scientists agree?
3. What advice would we give someone thinking of buying a sugar maple farm in New Hampshire?

## **DISCIPLINES ENCOMPASSED**

An effective strategy for delivering this activity could include allotting several class periods to represent various disciplines. Teachers in each of the following disciplines will readily find relevant ties between the content of the activity and course objectives:

- Earth System Science
- Ecology
- Environmental Science
- Geography
- Language Arts
- Mathematics
- Meteorology/Climate
- Social Studies
- Technology

## **PREREQUISITE KNOWLEDGE: TEACHER**

- Weather is the state of the atmosphere at a specific time and place.
- Climate is the sum of all statistical weather data for a place or region, or its average weather, including normal changes in precipitation and temperature over long periods. Climate is determined by the interaction of many factors, including ocean and air movements and the release of gases into the air by living organisms.

- Factors considered in determining weather and climate include air humidity and temperature, types and amounts of clouds and precipitation, pressure exerted by the air, and speed and direction of the wind.
- It is true that the concentrations of some greenhouse gases in the atmosphere are increasing. However, the climate system is very complicated and there are important aspects of it that are poorly observed or not observed at all. The scarcity of measurements has caused large gaps in our understanding of how the climate system works. There are many other processes that may offset global warming (i.e., negative feedbacks). For example, for every degree C of global warming due to greenhouse gases, the warming (or cooling) due to changes in global cloudiness ranges from 2 to 5 degrees C. Scientists are not even certain that the changes in global cloudiness, that might result from greenhouse gas warming, will add to or cancel out the warming. Small and subtle changes in climate processes that are difficult to observe can, if they persist for a long time, cause major impacts on climate.
- The most accurate way of tracking recent change in Earth's climate is by examining weather records and comparing them with historical records.
- The health of the world's forests are determined by a complex interaction of biological, chemical, and physical processes. Human activity, some planned and some accidental, has contributed to the degradation of forests in some areas. Local needs for income, fuel, food, and fodder have contributed to this degradation.

#### ■ Overview of Problem-Based Learning

This activity uses problem-based learning (PBL), whereby groups of students conduct investigations into the impact of climate variability and change on forests. Students will use the standard PBL model, summa-

rized below, to structure their analyses, research, and recommendations. Teachers interested in more information about this model should consult the PBL resources provided in the Resources: Teacher section.

Following the PBL model, students will:

- Read and analyze the problem scenario;
- List hypotheses, ideas, or hunches;
- List what is known;
- List what is unknown;
- List what needs to be done and plan the investigation;
- Develop a problem statement;
- Gather information; and
- Present findings and recommendations.

*NOTE: When using the PBL model, the teacher acts more as a coach in helping students investigate the problem. To that end, resources relevant to students' research follow the **Activity**. Teachers may provide these resources to students or have them develop their own list.*

### **PREREQUISITE KNOWLEDGE: STUDENTS**

- Understanding of the Scientific Method

### **KEY TERMS AND CONCEPTS**

The following terms and concepts will be presented in the following text and activities:

Climate  
Climate variability and change  
Ecosystem  
Global warming  
Greenhouse gases  
Negative feedbacks  
Weather

## **RESOURCES: TEACHER**

### **Climate Variability and Change**

THE TEACHER'S GUIDE TO GLOBAL WARMING is an interactive online lesson that will educate students about this highly debated environmental issue. Students will be given the chance to research global warming with global warming Web sites linked to this lesson, found at:

<http://weathereye.kgan.com/expert/warming/teachers.html>.

### **PBL Resources**

Center for Problem-Based Learning. Illinois Math and Science Academy

<http://www.imsa.edu/team/cpbl/cpbl.html>

Delisle, R. 1997. *How to Use Problem-Based Learning in the Classroom*. ASCD.

Exploring the Environment Web Page

<http://www.cotf.edu/ete/main.html>.

PBList Home Page

<http://ddsdx.uthscsa.edu/pblast/pblasthome.html#Print>

Sharan, Y. and S. Sharan. 1992. *Expanding Cooperative Learning Through Group Investigation*. Teachers College Press. New York, NY.

Torp, L. and S. Sage. 1998. *Problems As Possibilities: Problem-Based Learning for K–12 Education*. ASCD.

## ACTIVITY

# A Sticky Situation

This activity will answer the questions: What is climate variability and change? How is climate variability and change affecting forests?

### **MATERIALS**

- Handouts: *Scenario and Letter*, *Problem-Solving Model*, *Resources: Student*, and *Student Activity Sheets*.
- Access to school and public library
- Computers with Internet access

### **PROCEDURE**

*NOTE: This activity will be most effectively implemented in cooperative working groups. Student teams should choose, or be assigned, to investigate smaller segments of the larger issues. Scientific investigation of the problem would necessarily involve many different perspectives. Student teams could concentrate on the investigation of one component of the activity. In the final presentation, teams could use a jigsaw approach, with each team presenting a different perspective on the issues.*

#### **Step 1**

Place students into teams of 3 or 4.

#### **Step 2**

Distribute the *Scenario and Letter* and the *Problem-Solving Model* handouts found on the following pages. Each group will read and discuss the *Scenario and Letter*. Remind them that their “cousin” needs their informed guidance to make a decision.

#### **Step 3**

Ask them to now read the *Problem-Solving Model* to help them come up with sound advice. Follow the steps and prepare a 5–10 minute presentation. Be sure groups record all the information they research, including a bibliography, on their *Student Activity Sheets*.

#### **Step 4**

Assign groups presentation times.

## A STICKY SITUATION: Scenario and Letter

### SCENARIO

Have you ever heard the saying, “If something seems too good to be true, it probably is?” Put yourself in this situation: Imagine that you’ve received a letter from your favorite cousin, a likable fellow, but a bit of a dreamer. You know that in the past he’s tried to enlist your help on one questionable project or another, but this time seems to be a little different.

Your cousin’s letter is a bit more involved than it at first appears. There are so many things that he doesn’t seem to know about the issues. What advice will you give him? Well, enough of the commentary; here’s the letter.

### LETTER

Dear Cuz,

I know it’s been a while since you heard from me. That ostrich burger franchise that I bought in Peoria just didn’t seem to make it. Well, you can’t blame me for trying, right?

The real reason that I’m writing is to tell you that I’ve turned over a new leaf. No more get-rich schemes for me! I’ve decided to settle down and get out of the rat race once and for all. I’ve discovered that all I really want out of life is to enjoy the beauty of nature and live off the land. What, you might ask, will I do to pay the bills? Recently, I had the chance to spend some time in New Hampshire and, honestly, I just fell in love with the place. I’ve found a little (1,200-acre) farm in the White Mountains that is prime territory for one of America’s oldest industries, maple sugaring.

I thought that I’d write to ask for a little favor. No, wait! I don’t need any money (this time). What I do need is someone who has an eye for researching things like you do. You see, some local environmental group has been spreading the word that global warming might cause the maple trees in this area to migrate northward. I don’t know much about this kind of stuff, but I do know that the bank is NOT going to lend money for a tree farm with no trees. I’m enclosing all the stuff that I’ve been able to find on the subject here locally, but I hope you can find even more. Let me know if there’s anything else you need.

Looking forward to sharing maple syrup on some hot pancakes,

Your Favorite Cuz

**NOTE:** Now what do you do? Your cousin is counting on you to research this question and give him some feedback about sugar maple forests in New Hampshire. Where do you start? Fortunately, a problem-solving model and several resources are provided to help you begin your research.



## PROBLEM-SOLVING MODEL

1. Read and analyze the problem scenario:
  - Discuss the scenario with your team.
  - Don't be tempted to start thinking about potential solutions or to start looking for information.
2. List hypotheses, ideas, or hunches:
  - What do you *think* will happen to the sugar maple forests? List your ideas or hypotheses on the ***Student Activity Sheet***.
3. List what you already know:
  - Begin your list with the information contained in the scenario.
  - Add knowledge shared by other group members.
  - Record this information under the heading: "What do we know?" on the ***Student Activity Sheet***.
4. List what is unknown:
  - Prepare a list of questions your group thinks need to be answered to solve the problem.
  - Record them under the heading: "What do we need to know?" on the ***Student Activity Sheet***.
5. List what needs to be done:
  - List possible actions to be taken under the heading: "What should we do?" on the ***Student Activity Sheet***. Such actions may include questioning an expert, getting online data, or visiting a library to find answers to the questions developed in Step 4.
  - Prioritize the questions you are going to seek answers to, then divide up the questions among your team.
6. Develop a problem statement:
  - A problem statement is a one- or two-sentence idea that clearly identifies what your team is trying to solve, produce, respond to, test, or find out.
  - Record your statement on the ***Student Activity Sheet***.

## 7. Gather information:

- You and your team will gather, organize, analyze, and interpret information from multiple sources.
- Exchange ideas; think about solutions; weigh alternatives; and consider the pros and cons of potential courses of action.
- Record your information and resources on the on the ***Student Activity Sheet***.

## 8. Present findings:

- Prepare a report or presentation in which you and your group make recommendations, predictions, inferences, or other appropriate resolutions of the problem. Write an outline on your ***Student Activity Sheet***.
- Be prepared to support your positions. If appropriate, consider a multimedia presentation using images, graphics, or sound.

*NOTE: The steps in this model may have to be completed several times. Steps 2-6 may be conducted concurrently (at the same time), as new information becomes available. As more information is gathered, the problem statement may be refined or altered.*

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## RESOURCES: STUDENTS

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### Climate Variability and Change

- Since global warming appeared during the last decade as a serious environmental issue, it has been the subject of much debate. Global warming is defined as the warming of the Earth by greenhouse gases emitted into the atmosphere naturally or by mankind. More information may be found at:  
*<http://weathereye.kgan.com/expert/warming/explain.html>*
- The EPA Global Warming Site focuses on the science and impacts of global warming or climate variability and change, and on actions by governments, corporations, and organizations.  
*<http://www.epa.gov/globalwarming/>*

### The Maple Sugar Industry

Maple sugaring is an important part of the tradition and history of New England. The process of maple sugaring has been handed down from colonial times and continues to play an important role in preserving the economic strength of this region. Sales of maple syrup and other items related to the industry account for a significant portion of the income of the local area.

- History of the Maple Syrup Industry  
*<http://www.maple-erable.qc.ca/history.htm>*
- United States Maple Production, 1860–1949  
*<http://members.iquest.net/~childers/maple/histprod.html>*

### Forests

The following Web sites provide an overview of the potential impact of global warming and climate variability and change on forests:

- Worldwide Forest/Biodiversity  
*<http://forests.org>*

- Forest Migration  
*<http://forests.org/gopher/general/forclmig.txt>*
- Impact of Climate Change on Natural Vegetation  
*[http://www.meto.gov.uk/sec5/CR\\_div/Brochure97/vegetat.html](http://www.meto.gov.uk/sec5/CR_div/Brochure97/vegetat.html)*
- EPA Global Warming Impacts on Forests  
*<http://www.epa.gov/globalwarming/impacts/forests/index.html>*

## CONCLUSION

- Ask students to explain why they agree or disagree with the statement “Global warming is occurring.”
- Discuss with the groups their findings. What evidence have they found?
- What advice would they give someone thinking of buying a sugar maple farm in New Hampshire?
- Ask the students how or where they could find further information to make a more informed decision.

## EXTENSIONS

1. **Set up a debate.** Poll the students to see how many believe that global warming exists. Separate them into 2 groups: those who believe global warming is occurring (proponents) and those who don’t (opponents). The class should then come up with a statement to debate. Give each team time to research their position and prepare their debate.
2. **Greenhouse effect.** In groups, have students research what the greenhouse effect is. Then each group should be assigned a specific topic; some possible topics are listed below:
  - How the atmosphere has and is changing;
  - How the climate has changed;
  - Natural causes for the greenhouse effect;
  - Human influences on the greenhouse effect;
  - How scientists determine that global temperatures are increasing;
  - Past trends in climate variability and change (prehistorical); and
  - Technology used to study climate variability and change.
3. The following site contains tutorials, quizzes, activities, and teacher’s guides:  
<http://weathereye.kgan.com/cadet/lessons.html>

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## Student Activity Sheet: A STICKY SITUATION

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Names \_\_\_\_\_



1. Hypothesis, ideas, or hunches:



2. What do we know?



3. What do we need to know?



4. What should we do?

PRIORITY NO.      ACTION



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5. Problem statement:



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6. Gathered, organized, analyzed, and interpreted information. Be sure to include a listing of all resources used.



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7. Outline for presentation:

## Appendix A

# Bibliography

### **FORESTS**

- Worldwide Forest/Biodiversity  
<http://forests.org>
- Forest Migration  
<http://forests.org/gopher/general/forclmig.txt>
- Impact of Climate Change on Natural Vegetation  
[http://www.meto.gov.uk/sec5/CR\\_div/Brochure97/vegetat.html](http://www.meto.gov.uk/sec5/CR_div/Brochure97/vegetat.html)
- EPA Global Warming Impacts on Forests  
<http://www.epa.gov/globalwarming/impacts/forests/index.html>

### **CLIMATE VARIABILITY AND CHANGE**

- <http://weathereye.kgan.com/expert/warming/explain.html>
- <http://www.epa.gov/globalwarming/>

### **THE MAPLE SUGAR INDUSTRY**

- History of the Maple Syrup Industry  
<http://www.maple-erable.qc.ca/history.htm>
- United States Maple Production, 1860–1949  
<http://members.iquest.net/~childers/maple/histprod.html>

# Assessment Rubric & Answer Key

## Student Activity Sheet: A STICKY SITUATION

Answers will vary. Use rubric for grading.

SKILL	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
<b>Assessing the Situation</b>	Identify each of the issues addressed in the letter.	Identify three of the issues addressed in the letter.	Identify two of the issues addressed in the letter.	Identify at least one of the issues addressed in the letter.
<b>Action Plan</b>	Present a clear idea for investigating the issue that you identified.	Present clear, but incomplete ideas for investigating the situation, and addresses two major issues.	Present clear, but incomplete ideas for investigating the situation, and addresses three major issues.	Develop a clear plan of action to investigate each of the issues.
<b>Gathering Evidence</b>	Show that you have researched evidence both for and against each of the issues identified.	Show that you have researched evidence both for and against each of the three issues identified.	Show that you have researched evidence both for and against each of the two issues identified.	Show that you have researched evidence both for and against the issue that you identified.
<b>Analysis</b>	Show that you understand the ways in which each of the issues relate to each other.	Show that you understand the ways in which each of the three issues relate to each other.	Show that you understand the ways in which each of the two issues relate to each other.	Explain why you feel that this issue is important.
<b>Presentation</b>	Give a clear presentation that identifies all of the issues, how you chose to investigate them, and what you decided to do about them.	Give a clear presentation that includes two of the following: identifying all of the issues, how you chose to investigate them, and what you decided to do about them.	Give a clear presentation that includes one of the following: identifying all of the issues, how you chose to investigate them, and what you decided to do about them.	Presentation is not clear.

## Appendix C

# National Education Standards

***This activity responds to the following National Education Standards:***

### **STANDARDS FOR THE ENGLISH LANGUAGE ARTS**

**Standard 3:** Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

**Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

**Standard 5:** Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

**Standard 6:** Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss different print and non-print texts.

**Standard 7:** Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

**Standard 8:** Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

**Standard 12:** Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

*National Council of Teachers of English and International Reading Association. 1996. **Standards for the English Language Arts** p 24–46. Urbana, Illinois and Newark, Delaware: National Council of Teachers of English and International Reading Association.*

### **NATIONAL GEOGRAPHY STANDARDS GEOGRAPHY FOR LIFE (5–8)**

**Geography Standard 7: Physical Systems.** The physical processes that shape the patterns of Earth's surface.

**Geography Standard 8: Physical Systems.** The characteristics and spatial distribution of ecosystems on Earth's surface.

**Geography Standard 15: Environment and Society.** How physical systems affect human systems.

*American Geographical Society, Association of American Geographers, National Council for Geographic Education, and National Geographic Society. 1994. **Geography for Life: National Geography Standards** p. 143–182. Washington, DC: National Geographic Research and Exploration.*

### **CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS (5–8)**

**Standard 1:** Mathematics as problem solving.

**Standard 2:** Mathematics as communication.

**Standard 3:** Mathematics as reasoning.

**Standard 4:** Mathematical connections.

*National Council of Teachers of Mathematics. 1989. **Curriculum and Evaluation Standards for School Mathematics** p. 65–119. Reston, VA: The National Council of Teachers of Mathematics, Inc.*



## NATIONAL SCIENCE EDUCATION STANDARDS (5–8)

### CONTENT STANDARD: K–12

#### Unifying Concepts and Processes

**Standard:** As a result of activities in grades K–12, all students should develop understanding and abilities aligned with the following concepts and processes:

- Systems, orders, and organization
- Evidence, models, and explanation
- Constancy, change, and measurement

*National Research Council. 1996. National Science Education Standards p. 115–119. Washington, DC: National Academy Press.*

### CONTENT STANDARDS: 5–8

#### Science as Inquiry

**Content Standard A:** As a result of activities in grades 5–8, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

#### Life Science

**Content Standard C:** As a result of activities in grades 5–8, all students should develop an understanding of:

- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

#### Earth and Space Science

**Content Standard D:** As a result of activities in grades 5–8, all students should develop an understanding of:

- Structure of the Earth system

#### Science and Technology

**Content Standard E:** As a result of activities in grades 5–8, all students should develop:

- Abilities of technological design
- Understandings about science and technology

#### Science in Personal and Social Perspectives

**Content Standard F:** As a result of activities in grades 5–8, all students should develop an understanding of:

- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

#### History and Nature of Science

**Content Standard G:** As a result of activities in grades 5–8, all students should develop an understanding of:

- Science as a human endeavor
- Nature of science

*National Research Council. 1996. National Science Education Standards p. 143–171. Washington, DC: National Academy Press.*

## CURRICULUM STANDARDS FOR SOCIAL STUDIES

**Strand 3: People, Places, & Environments.** Social studies programs should include experiences that provide for the study of people, places, and environments.

**Strand 8: Science, Technology, & Society.** Social studies programs should include experiences that provide for the study of relationships among science, technology, and society.

**Strand 9: Global Connections.** Social studies programs should include experiences that provide for the study of global connections and interdependence.

*National Council for the Social Studies. 1994. Expectations of Excellence: Curriculum Standards for the Social Studies p. 21–30. Washington, DC: National Council for the Social Studies.*

**INSTITUTE**  
*for* **GLOBAL**  
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